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Title: Cross Layer Trigger Based Handover Schemes in Wireless Networks

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ABSTRACT

The demand for uninterrupted services by users can be accomplished by employing efficient handover algorithms. A Cross Layer Trigger based Handover approach is proposed in this work. This work presents mechanisms for generating a trigger at lower layers according to some predefined parameters using cross layer information and trigger is then used to provide a prior intimation at higher layers to get prepared for handover in advance. In addition, the cross layer trigger is also utilized to select appropriate target network and to perform handover procedure efficiently. The proposed cross layer trigger based handover scheme will enhance the performance of wireless networks in terms of handover delay, probability of handover failure, handover rate, false handover, packet loss and throughput.

Keywords: Handover, Cross layer, Trigger, Wireless networks, handover failure, handover rate.

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1. Introduction

Mobile users are demanding anywhere and anytime access to high speed data, real and non-real time multimedia services from wireless systems. Most of the wireless networks have been divided into independent layers and each layer has its specified job without any interaction but layered architecture leads to inefficiency due to effect of performance of one layer on another layer. Mobility management is responsible for location management and handover (HO) management. The performance of handover can be enhanced by exchanging information between different layers. A Cross Layer Trigger based Handover approach is proposed in this work. This work presents mechanisms for generating handover triggers at physical layer in order to provide a prior intimation at higher layers to get prepared for handover in advance. The exchange of information between different layers and intimation of handover events is facilitated by the IEEE 802.21, media independent handover (MIH) framework. The handover process is completed in three phases: HO initiation phase, Target network selection and HO execution phase. The handover trigger is generated in first phase. The generation of handover triggers can be based on single or multiple criteria. Since performance of a wireless network is closely related with the execution timing of HO, thus it is very essential to initiate the HO at appropriate time so that the HO procedures can be accomplished before link down. The second phase is responsible for selecting the target network to which HO to be done. In third phase, the user is actually connected to the new link. The overall performance of wireless networks depends on three phases and can be measured in terms of link failure, number of handovers, false handover probability, handover latency, packet loss and throughput which will in turn supports the seamless mobility throughout the network.

2. Literature Review

The advanced mobility support calls for a coordination of all the layers as discussed above. The performance of a Cross Layer based Handover can be measured in terms of various parameters like HO delay or latency, Bandwidth and resource management, power consumption, HO cost, packet loss, Quality of Service. These parameters are optimized using various Cross Layer schemes [1-5] by various researchers in the literature.

The authors in [6] introduced an arrangement of all the mesh routers to facilitate efficient inter gateway handoff supports from multiple layers. The information obtained from the L2 is utilized to predict the L3 and L5 handoffs in advance. Previous Access Router (PAR) is made to validate the proposed new IP address before MN disconnects from PAR to remove Duplicate Address Detection (DAD) delay in [19]. The Trigger Management architecture to feed HIP, Mobile IP, and Session Handovers is proposed in [10] for vertical handover controller (VERHO) system. Each interface is supposed to get a calculated preference value based on the values of different parameters like cost, power consumption, and support for wireless QoS or bandwidth. Effective and timely link-layer trigger mechanisms can significantly influence the handover performance. An LGD trigger should be fired at least in the required handover time before the Link Down (LD) event. The required handover time is different according to the topologies, layer 3 handover protocols, and handover policies of the neighbor networks and dynamic in nature due to mobility [38]. If HO initiation is on appropriate time, HO latency and service disruption time is reduced as well as preceding interface is utilized at the maximum. The authors in [46] included a Triggering Engine on top of the IEEE 802.21 services in order to introduce upper layer events and end-to end event based signaling. Trigger generator brings a flexible way to establish an event based signaling between internal working modules and end hosts. The use of cascaded trigger generators allows trigger delivery between the local Application Controller and the one running on the server to facilitate end to end adaptation.

MIPv6 and SIP are the most widely deployed protocols for handling mobility and for session control respectively but some functions are repeated leads to inefficiency. Cross layer scheme can be utilized for minimizing the end to end HO delay in case of integrated SIP and MIPV6 techniques [16][1]. The Care-of Addresses can be used directly for the short-lived

message transactions in call initiation and layer3 location information can be used in session setup signaling [16]. While in [1], a cross module is introduced between home agent and serving-Call Session Control functions(S-CSCF), a database function of control plane of IP Multimedia Subsystem （IMS）. Through the cross-layer module, the binding update message received by HA can be translated and forwarded to S-CSCF to trigger the registration procedure in IMS. So the signaling between mobile node and home network can be reduced dramatically and can provide better mobility management for real-time service in IMS and has good scalability. FMIPv6 (Fast handover for Mobile IPv6) protocol uses the L2 trigger information which can solve the unacceptable HO (Handover) latency and the data loss problems of MIPv6. Transport layer and MAC cross-layer interaction (i.e. the interaction between TCP PEP (Performance Enhancing Proxy) and DAMA (Demand Assignment Multiple Access)) can be utilized to optimize the use of available resources and flow control [2]. The authors in [28] and [29] have shown the significant impact of design parameters at physical/data-link layer on TCP throughput of wireless networks. The probability of false HO at network layer is minimized by calculating MT's current position and moving direction with the help of GPS and velocity information at link layer [43]. The probability of false HO at network layer is minimized by calculating MT's current position and moving direction with the help of GPS and velocity information at link layer [43]. Adaptive modulation and coding (AMC) strategies are employed at the physical layer to optimize spectral efficiency subject to QOS. Fast Link Adaptation (FLA) is an optimization process which shows relation between instantaneous throughput and transmission rate of modulation and coding scheme (MCS) and claims for a PHY-MAC cross layer design [30]. Because of numerous advantages of cross layer approach, Most of the recent standards like IEEE 802.11WLANs (Wi-Fi), IEEE 802.16 WMANs (WiMAX), IEEE 802.21 are adopting cross layer design to refine the existing HO procedures [18][35]. The authors in [35] Summarizes the various cross layer techniques for HO adopted by various standardization bodies like IEEE, IETF, and 3GPP for seamless HO. The HO can be optimized in WiMAX by exchanging security keys between BS and SS during scanning phase prior to HO thus neglecting the need of authorization. Some researchers used CL with integration of two HO protocols to enhance the performance of wireless networks [4][23] [31] [32] [36] [37]. SIP and MAC cross-layer interactions can be used to support the interworking between WiMAX and DVB-RCS, and multimedia QoS-aware application. The authors in [48], [33] and [25] used cross layer schemes to find a feasible route

according to application QoS requirements in mobile ad hoc networks. The authors in [48] offered the cooperation between the Admission Control enabled On-demand Routing (ACOR) protocol and the new QoS-based IEEE 802.11e MAC layer. The loosely coupled cross-layer design for distributed opportunistic scheduling (Dist) in MAC layer and integrated multi-constrained QoS routing (IQoSR) algorithms in network layer is assessed as compared to conventional Round robin scheduler (RR) and AODV routing protocol in [33]. A route capacity estimation based admission control algorithm is also used in network layer (Dist+IQoSR+RC-CAC) to provide GoS. The authors in [25] Presents a cross-layer optimized MAC protocol, referred as hybrid-MAC (HMAC) especially suitable for wireless sensor networks in terms of energy efficiency, latency, and packet delivery ratio. The authors in [27] used a new CSMA/CA model based on a Markov chain which captures the carrier-sensing errors like false alarm and miss-detection at the physical layer. The system throughput and delay as functions of the sensing error probabilities, as well as other CSMA/CA parameters, are obtained. It also analyzed their sensitivity with respect to a key physical-layer parameter, i.e., the sensing threshold. For high velocity applications, the HO threshold is set variably according to the Received Signal Strength Indicator (RSSI) as well as MS mobility, named as velocity-adaptive handover scheme [20].

3. **Description Of Broad Area/Topic**

Most of the current work on Wireless Networks protocol analysis and design is mainly based on a layered approach. This layered architecture provides modularity and transparency between the layers. However, the spatial reuse of the spectral frequency, the broadcast, unstable and error prone nature of the channel and different operational time scales for protocol layers are the limitations of layered approach Wireless Networks. As the performance of one layer affects other layers therefore, we address the cross layer networking where data link and MAC layer information is shared with higher layers for mobile users. Mobility management allows mobile terminals to move seamlessly across wireless access networks while continuing to enjoy the services they are subscribed to in their home networks. It also allows for choice of a preferred network to carry user's services in a way that is satisfying to the user. The cross layer scheme can be used effectively to improve a network performance during a HO.

Mobility management comprises of location management and handoff management. The previous one tracks the mobile for successful information delivery while the handoff management maintains active connections for roaming mobile terminals. However we will use cross layer concept for handover management in the proposed approach which will be organized as follows: A HO initiation trigger will be generated by the trigger generator if parameters received from different layers goes below threshold value down for the current network. Then this trigger will intimate the higher layers to prepare for handover before actual handover initiation. The network layer, transport layer and application layer can perform some functions like Route discovery, new IP address and SIP Re-invite respectively in advance. Target network selection is also done with the help of parameters collected from different layers. It will reduce the handover delay and service disruption time which will finally decrease the packet lost and increase throughput during handover.

4. Objectives

Performance Metrics Optimization during handover in wireless system is the main objective of this dissertation. The performance metrics can be optimized to meet certain targets.

Design Targets for a Wireless network:
We aim to achieve the following objectives:

1. Minimize handover rate
2. Minimize call blocking probability during handover
3. Maintaining QoS during handover
4. Optimizing HO parameters
5. Maximizing resource utilization

5. **Methodology**

The following research methodologies will be opted in this research:

1. Analytical

   In this work, some parameters like HO delay, packet loss, HO cost and throughput will be calculated analytically with the help of mathematical equations.

2. Simulation

   The HO performance of the proposed scheme will be compared with the existing techniques with the help of extensive simulation. The MATLAB will be used to demonstrate the enhanced performance of the proposed scheme.

3. Experimental (if possible)

   An experimental test bed for WLAN is planned to be prepared to study the HO schemes practically if possible. This will show the significance of Cross layer trigger based handover in real time applications.

6. **Expected Outcome Of Research**

We aim to device new technique named as cross layer trigger based handover which will make use of different layers for triggering the HO and selecting best target network. It will reduce probability of HO failure, probability of false HO initiation, minimize number of HOs. It will also improve QoS in terms of Packet loss and throughput which will enhance the overall system performance of wireless networks and offers the seamless mobility for the users.

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